the ENERGY lab

PROJECT FACTS

Carbon Storage – RCSP

Small Scale Field Test Demonstrating CO_2 Sequestration in Arbuckle Saline Aquifer and by CO_2-EOR at Wellington Field, Sumner County, Kansas

Background

The goal of the Department of Energy's (DOE) Carbon Storage Program is to develop and advance technologies to significantly improve the effectiveness of geologic carbon storage, reduce implementation costs, and prepare for widespread commercial deployment between 2025 and 2035. Research to develop these technologies will ensure safe and permanent storage of carbon dioxide (CO_2) to reduce greenhouse gas (GHG) emissions without adversely affecting energy use or hindering economic growth.

Geologic carbon storage involves securely and permanently injecting CO_2 into onshore and offshore underground formations. Current research and field studies are focused on developing a better understanding of the science and technologies needed for safe and permanent CO_2 storage in onshore and offshore storage reservoirs, which include: clastic formations, carbonate formations, unmineable coal seams, organic-rich shales, and basalt interflow zones. DOE's Storage Program is accomplishing this through: (1) developing technologies that address technical challenges and ensure the cost effectiveness of carbon storage, (2) validating technologies that ensure safe and permanent carbon storage, and (3) facilitating public, industry, and international community awareness of research and development (R&D) efforts underway related to carbon storage. These technologies will facilitate future CO_2 management for coal-based electric power generating facilities and other industrial CO_2 emitters by enabling the safe, cost-effective, permanent geologic storage and utilization of CO_2 in all storage types.

The Carbon Storage program is comprised of three primary technology areas (1) Core Storage R&D, (2) Storage Infrastructure, and (3) Strategic Program Support. These three areas work together to address significant technical challenges in order to meet program goals that support the scale-up and widespread deployment of carbon capture and storage (CCS).The Storage Infrastructure portion of the Carbon Storage Division research portfolio focuses on conducting research in the field, including carrying out regional characterization and field validation testing to demonstrate that different storage types in various formation classes, distributed over different geographic regions, and both onshore and offshore, have the capability to safely and permanently store CO_2. This research will provide a sound basis for commercial-scale CO_2 projects. The Storage Infrastructure Technology Area works to validate new technologies and benefits from specific solutions developed in the Core Storage R&D component. In turn, data gaps and lessons learned from small- and large-scale field projects are fed back to the Core Storage R&D component to guide future R&D.

CONTACTS

Traci Rodosta
Carbon Storage Program Technology Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507
304-285-1345
traci.rodosta@netl.doe.gov

Brian Dressel
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-7313
brian.dressel@netl.doe.gov

W. Lynn Watney
Principal Investigator
The University of Kansas
Kansas Geological Survey
Lawrence, KS 66047
785- 864-2184
lwatney@kgs.ku.edu

PARTNERS

Kansas Geological Survey
Kansas State University
BEREXCO, LLC
Lawrence Berkley National Laboratory

PROJECT DURATION

Start Date	End Date
10/01/2011	09/30/2016

COST

Total Project Value
$14,720,734

DOE/Non-DOE Share
$11,484,494 / $3,236,240

PROJECT NUMBER

DE-FE0006821

U.S. DEPARTMENT OF ENERGY

Research within the Storage Infrastructure Technology Area is focused on next-generation onshore characterization projects, offshore prospective storage resource assessment, and "fit-for-purpose" projects. "Fit-for-Purpose" projects are focused on developing specific subsurface engineering approaches that address research needs critical for advancing CCS to commercial scale. These projects include CO_2 injection field tests, as well as applied research and development projects. The field tests augment the information gathered during the Regional Carbon Sequestration Partnership (RCSP) Validation Phase small-scale field projects. The RCSP small-scale tests have provided valuable data, but complex issues surrounding the processes associated with geologic CO_2 storage and monitoring across various types of formations and depositional environments still remain. The University of Kansas project is conducting a stacked reservoir injection pilot study to further evaluate the feasibility and efficacy of long-term CO_2 storage in saline reservoirs and the use of CO_2 in enhanced oil recovery operations (EOR) in the mid-continent.

Project Description

This project aims to inject a maximum of 40,000 metric tons of CO_2 under super-critical conditions into the Lower Arbuckle Group in Sumner County, Kansas. The Arbuckle Group is an extensive saline aquifer in southern Kansas consisting of fractured dolomitic sandstone and dolomite. Additionally, a maximum of 30,000 metric tons will be injected into the overlying oil-bearing dolomite of the Wellington Oilfield so that both geologic storage of CO_2 in a saline aquifer and miscible CO_2-enhanced oil recovery potential will be investigated, as well as, conduct an evaluation of induced seismicity from injection activities. The Wellington Field is similar to other oil fields in southern Kansas that have produced over 300 million barrels of oil and in excess of 2.5 trillion cubic feet of gas.

Data previously collected from the study area have been used to develop a robust Arbuckle geomodel (Figure 1) from which reservoir simulation studies will be used to predict the location and composition of the CO_2 plume (Figure 2). Additional activities conducted during pre-injection will aid refinement of geologic, seismic, and engineering models.

The project is using state-of-the-art monitoring techniques to track and visualize the location of stored CO_2 as well as estimate the amount of CO_2 in solution, as residual gas, and mineralized for both injection efforts. These techniques also will provide data to detect potential CO_2 leakage, conduct efficient CO_2 fate and transport analyses, and validate a CO_2 storage simulation model and compare MVA techniques and technologies. Monitoring includes: (1) in situ and surface seismic methods; (2) gas and fluid sampling at five levels including in situ Arbuckle, underpressured Mississippian reservoir, near-surface (~600 ft) shallow sub evaporite, shallow unconfined freshwater aquifer (<100 ft), and soil; (3) InSAR (Interferometric Synthetic Aperture Radar) and LiDAR (Light Detection And Ranging) to detect millimeter-scale scale surface deformation, and (4) continuous GPS and array of sensitive seismometers to measure earthquake activity. In situ measurements of seismic and fluid properties will establish location and composition of the CO_2 plume. In situ

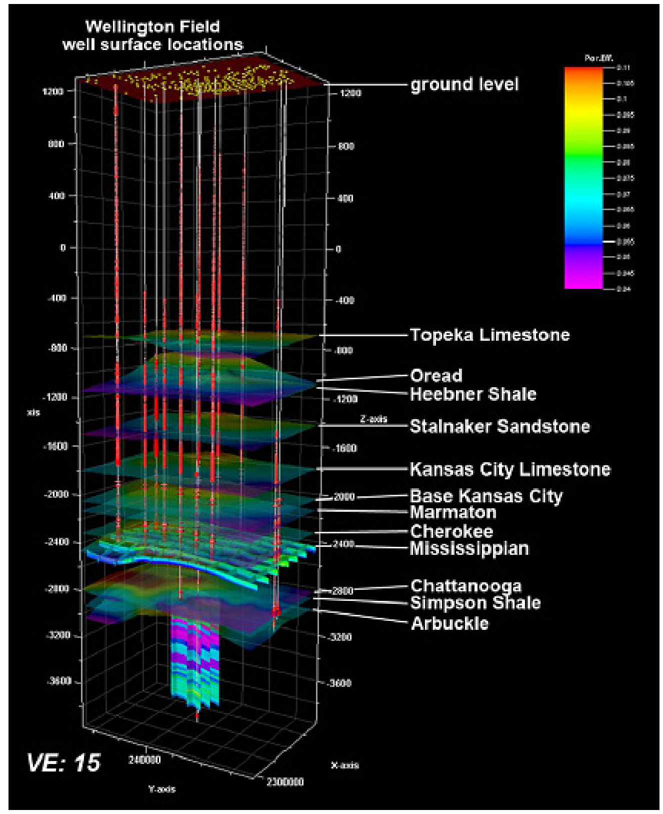

Figure 1. 3-D model of Wellington Field extending from the Precambrian basement to surface.

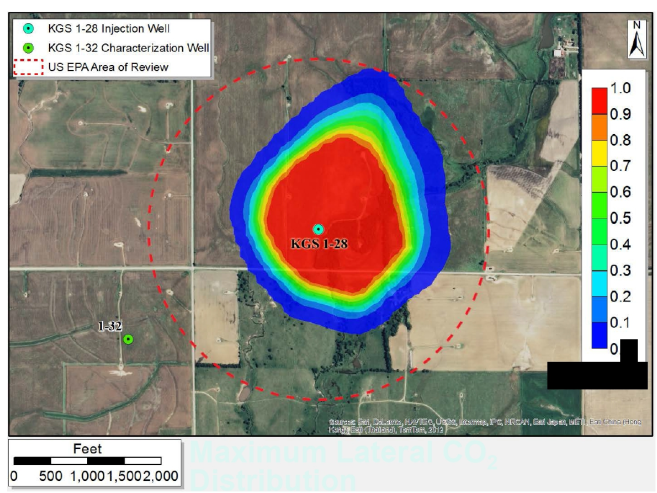

Figure 2. Modeling and simulation results of projected plume evolution and Area of Review.

monitoring instruments include CASSM (continuous active source seismic monitoring), time-lapse crosshole seismic tomography, and U-Tube fluid sampler to record CO_2 plume velocity and composition. In situ sampling will include migrated CO_2 and tracers, pressure, and temperature. Soil gas probes will measure concentrations and flux chemical constituents.

Goals/Objectives

This project is evaluating carbon storage efficiency and permanence through its efforts to monitor and track the CO_2 plumes in both the saline aquifer and the oil-bearing Mississippian formation. Data obtained from the study will aid the development of a rapid-response mitigation plan to minimize any potential CO_2 leakage, a comprehensive risk management strategy, and best practice methodologies for MVA and injection site closure. The proposed simulation and experiments will systematically establish proof-of-feasibility of a novel concept that uses multiple in situ and ex situ monitoring systems in tandem to track the location of injected CO_2. The data gathered as part of this research effort and pilot study will be shared with the RCSP Southwest Regional Partnership (SWP), integrated into the National Carbon Sequestration Database and Geographic Information System (NATCARB), and integrated into the Fifth Edition of the Carbon Storage Atlas.

Accomplishments

- A Class VI Underground Injection Control (UIC) Permit for CO_2 injection into the Arbuckle Group has been submitted and is currently under review by the U.S. EPA (Region 7).
- Two vendors have been secured to supply CO_2 for the injection portion of the research effort.
- The research team has acquired several monitoring platforms for tracking the CO_2 plume during and after injection operations. These instruments include several seismometers, high-resolution GPS/InSAR datasets, and collection of baseline ground water (near surface) sampling results.

Benefits

The University of Kansas dual injection/EOR project is advancing the science and practice of carbon storage in the mid-continent by providing a highly constrained analog model, evaluating MVA best practices tailored to the geologic setting, optimizing potential remediation methods and risk management, and providing technical information and training to foster additional projects and facilitate public discourse on liability and risk management issues. The project is also confirming storage resources for the target formations, and developing guidelines for well completion, injection operations, and well closure to maximize storage potential and ensure storage permanence. The project team is also developing public outreach plans to communicate the scientific validation and development of CCS projects to various stakeholders, and is also working with regulatory agencies to finalize a Class VI UIC permit.

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